CHAPTER 2

Ground Water Resources within the Lower West Coast Planning Area

The hydrogeology of South Florida is diverse. It includes aquifers which are confined (in which ground water is under greater than atmospheric pressure and isolated from vertical recharge), semi-confined (having some vertical recharge), and unconfined (ground water is at atmospheric pressure and water levels correspond to the Water Table). Within an individual aquifer, hydraulic properties and water quality may vary both vertically and horizontally. Because of this diversity, ground water supply potential varies greatly from one place to another. This chapter contains a generalized description of the groundwater resources of the study area and presents information relevant to the establishment of minimum aquifer levels. For a more detailed description of the hydrogeology of the area, along with addition data, the reader is directed to the references included in the end of this report.

The three major aquifer systems: the Surficial Aquifer System (SAS), the Intermediate Aquifer System (IAS) and the Floridan Aquifer System (FAS) are described on Figure 2 and 3. The generalized aquifer characteristics summarized by county are included on Tables 1 through 5. Maps showing the structure top elevation, hydraulic conductivity/transmissivity, are included on Figures 4 through 10.

I. Surficial Aquifer System

The SAS may be divided into two aquifers, the Water Table and Lower Tamiami, which are separated by leaky confining beds over much of the area. In northern Lee County, where the confining beds are absent or insignificant, the Lower Tamiami is not a separate aquifer but part of the unconfined Water Table aquifer. The thickness of the SAS ranges from more than 200 feet in central and southern Collier County to less than 20 feet along the Caloosahatchee River in eastern Lee and Hendry counties.

The Water Table aquifer includes all sediments from land surface to the top of the Tamiami confining beds. Within Lee County, four major public water supply wellfields, all located in areas where the confining beds are absent, pump water from the Water Table aquifer. These are Lee County Utilities (Corkscrew Wellfield and Green Meadows Wellfield), Gulf Utilities, and the city of Fort Myers. The aquifer also furnishes irrigation water for many uses, including vegetables, nurseries, and landscape irrigation. In Hendry County, the Water Table aquifer is generally used only where no suitable alternative is available, though it may yield copious quantities of water in isolated areas. It produces good quality water, except in areas near LaBelle and parts of the coast, that have high concentrations of chlorides and dissolved solids, and isolated areas with high iron concentrations.

The Lower Tamiami aquifer is the most prolific aquifer in southeast Hendry and all of Collier counties. The Lower Tamiami aquifer supplies drinking water to Bonita Springs**,** Collier County, City of Naples, Immokalee utilities as well as meeting the demands of most landscape, recreational and agricultural irrigation wells. Salt water occurs within the aquifer along the Lee and Collier coastlines. As a result, consumptive use withdrawals have been carefully managed and the interface has remained stable for more than 15 years. Remnant brackish depositional water occurs within the aquifer in localized areas where 1) groundwater flow divides occur that resist flushing and 2) in low permeable basal sediments that also resist freshwater flushing.

II. Intermediate Aquifer System

The IAS consists of five zones of alternating confining and producing units which are further described in other District publications (Knapp et al., 1984, and Smith and Adams, 1988;). The two producing zones, which comprise the IAS, include the Sandstone and Mid-Hawthorn aquifers.

The Sandstone aquifer has variable thickness. It averages over 100 feet near Immokalee and portions of central Lee County, but pinches out to the south around Alligator Alley, to the northwest in Cape Coral, and to the east in the middle of Hendry County. The productivity of the Sandstone aquifer is highly variable. It provides all of the water withdrawn by the Lehigh Acres Public Water Supply Wellfield and a portion of that withdrawn by the Lee County Corkscrew and Green Meadows wellfields. In western Hendry County, where the Lower Tamiami aquifer is absent, it is an important source of water for agricultural irrigation, but is utilized near capacity in support of large scale agricultural operations. This high degree of utilization manifests itself during droughts when domestic centrifugal wells loss service due to low water levels. The Sandstone has no source of saline water and receives recharge as vertical seepage from overlying aquifers.

Although present throughout the LWC Planning Area, the Mid-Hawthorn Aquifer is consistently low yielding and characterized with low storativity and low leakance. Its thickness is variable and relatively thin (it rarely exceeds 80 feet). This variability, combined with the presence of interbedded low permeability layers, results in low productivity of the aquifer. Water quality in central Lee County, the structural high for the aquifer, is excellent. As a result, the aquifer is used extensively here for domestic potable and irrigation use. Due to the low yield and high use, the potentiomentric surface of the Mid-Hawthorn has declined as much as eighty feet over the last thirty years without measurable changes in water quality. Where the aquifer dips to the south and west, salinity levels increase (chloride concentrations of 300 to 600 mg/l). Despite the higher salinity levels, the aquifer is continuing to experience increasing demands in southern coastal Lee County where the other shallow fresh water aquifers are not permitable due to saltwater constraints. As a result, groundwater levels within the Mid-Hawthorn aquifer in Lee County are approaching the top of the aquifer in some localized areas.

The Mid-Hawthorn aquifer formerly provided water for the city of Cape Coral and the Greater Pine Island water utilities. However, its limited water-producing characteristics made

it an unreliable source. Both utilities have been forced to develop other sources. It is also used for domestic self-supply in those areas of Cape Coral not served by city water and for small water utilities north of the Caloosahatchee River. Elsewhere the aquifer is used only occasionally for agricultural irrigation.

III. Floridan Aquifer System

The FAS, which underlies all of Florida and portions of southern Georgia and Alabama, contains several distinct producing zones which are described by Wedderburn et al., 1982. Although it is the principal source of water in Central Florida, the FAS yields only non-potable water throughout most of the LWC Planning Area. The quality of water in the FAS deteriorates southward, increasing in hardness and salinity. Salinity also increases with depth, making the deeper producing zones less suitable for development than those near the top of the system.

Developments in desalination technology have made treatment of water from the upper portion of the FAS feasible where chloride concentrations are not prohibitively high. The most productive zones are the lower Hawthorn and Suwannee aquifers. Currently, several utilities including the city of Cape Coral, Greater Pine Island, Collier County, Marco Island Utilities, and Island Water Association (Sanibel), obtain water from the lower Hawthorn or Suwannee aquifers. Elsewhere, the aquifers supply only a few agricultural irrigation wells. Improvements in desalination treatment technology will make development of these aquifers increasingly feasible; continuing increases in the demand for water in the LWC Planning Area, moreover, will make it necessary. Portions of the producing zones may also have potential for use in ASR projects.

In the deeper producing zones of the FAS, there are areas of extremely high transmissivity, known as "boulder zones." Although they are not used as supply sources within the LWC Planning Area due to the high salinity and mineral content, these formations may serve other purposes. Some areas of the boulder zones have been used as disposal areas for treated wastewater effluent or residual brines from the desalination process.

IV. Surface Water/Ground Water Relationships

In the preceding sections, surface water and ground water resources have been addressed as separate entities. In many ways, however, they are highly interdependent. The construction and operation of surface water management systems affect the quantity and distribution of recharge to the SAS. Surface water management systems within the LWC Planning Area function primarily as aquifer drains, since the ground water levels generally exceed the surface water elevations within the LWC Planning Area. The Caloosahatchee River and the Gulf of Mexico act as regional ground water discharge points (Wedderburn et al., 1982). Ground water seepage represents significant inflows to the Caloosahatchee, Orange, Imperial, and Estero rivers as well as base flows to wetland and slough systems. During the wet season, some recharge to the SAS may occur from drainage canals, small lakes such as Lake Trafford and low lying areas where stormwater levels may temporarily exceed local ground water levels (Knapp, 1984; Smith and Adams, 1988). Surface water management systems also impact

aquifer recharge by diverting rainfall from an area before it has time to percolate down to the Water Table. Once diverted, this water may contribute to aquifer recharge elsewhere in the system, supply a downstream consumptive use, or it may be lost to evapotranspiration (ET) or discharged to tide.

Recharge to the Water Table is provided by percolation of rainfall. The vertical movement of ground water from the Water Table in turn provides recharge to the underlying Lower Tamiami and Sandstone aquifers. This is represented on a large scale by similarities between regional potentiometric maps of the three aquifers during the 1970s and early 1980s (Wedderburn et. al., 1982). The evidence of vertical recharge is also demonstrated on a local scale where clustered monitor wells show a downward gradient across the three aquifers. However, this vertical connection is not very great (except when confining beds are absent) as evidenced by more recent water level data between layers. During the early 1980s, the water level differences between the Water Table aquifer and the Sandstone aquifer in central Lee County were approximately five feet at any given time. However, as consumptive uses of the Sandstone began to appear and increased the differences between the two aquifers grew in magnitude (to over twenty feet at times) and also showed time lags between hydrologic events. This suggests that significant confinement exist between the units, which provide buffering from withdrawals within the semi-confined aquifers.

The Sandstone Aquifer comes into direct contact with the SAS northeast of Immokalee (Smith and Adams, 1988), In those areas the Sandstone aquifer responds almost immediately to rain events, but the aquifer is receiving the water through the SAS and it does not have direct contact with surface water systems. The remainder of the IAS is not hydraulically connected to surface water.

The potentiometric surface of the Mid-Hawthorn aquifer shows that this unit is recharged by the underlying FAS. This is supported by pre-development water level data that showed the Mid-Hawthorn free flowed at land surface (an upward gradient). This recharge pattern is also supported by the characteristic of the water quality. Water from both the FAS and the Mid-Hawthorn are sodium chloride waters while water from the shallower semi-confined aquifers are calcium bicarbonate type waters (Knapp et. al. 1984).

The FAS is not hydraulically connected to surface water within the LWC Planning Area. Recharge to the system occurs as lateral movement from the recharge area in central Florida. As a result of this very slow process, the depositional waters have not yet been flushed from the system and the waters are salty. Because the flow rates are so low, the water quality is generally stratified with higher levels of salinity occurring with depth. When using the FAS water for irrigation, it is usually diluted with surface water to achieve an acceptable quality for use. Consequently, surface water availability for dilution purposes can be a limiting factor on the use of FAS water. However, because the system is hydraulically isolated from the surface, the FAS is drought proof and won't cause wetland impacts. This factor, combined with improvements in the desalting technology and the hundreds of feet of available brackish water, has made the FAS an attractive source for public water supply and aquifer storage and recovery systems.

Table 1: Ground Water Systems in Charlotte County

Aquifer System	Aquifer Unit	Thickness (Feet)	Water Resource Potential
Surficial Aquifer System	surficial Aquifer	0-70	Aquifer productivity is variable. Most wells yield less than 50 gpm, but can range as high as 600-700 gpm in wells tapping the Caloosahatchee marl in southeastern Charlotte County.
Intermediate Aquifer System	Sandstone Aquifer/ Mid- Hawthorn Aquifer	70-260	Low yield, fresh water. Important source for domestic and irrigation wells in southeastern Charlotte County.
Florida Aquifer System	Lower Hawthorn Aquifer/ Upper Tampa Aquifer	150-300	Widely used for irrigation, but requires desalination treatment for potable use. Most productive zones lies
	Suwannee Aquifer	200-300	Most productive aquifer in Charlotte County, but water requires desalination treatment for potable uses. Water quality deteriorates from east to west and with depth.
	Ocala Group	200-300	

Table 2: Ground Water Systems in Collier County

Aquifer System	Aquifer Unit	Thickness (Feet)	Water Resource Potential
Surficial Aquifer System	Water Table Aquifer	20-100	The Water Table and the Lower Tamiami aquifers are the most productive sources in the County. Excellent quality water except for isolated areas with high iron content. Potential for saltwater intrusion in coastal areas. In areas where the confining zone is absent, there is direct hydraulic connection of the Lower Tamiami and the Water Table Aquifer.
	Lower Tamiami Aquifer	40-180	
Intermediate Aquifer System	Sandstone Aquifer	0-110	Yields large amounts of fresh water in the northern portion of the county but is absent south of Alligator Alley. Suitable for mostly agricultural uses.
	Mid-Hawthorn Aquifer	60-120	Aquifer is low yielding and produces poor quality water. Suitable only for small irrigation uses.
Florida Aquifer System	Lower Hawthorn/ Suwannee Aquifer	100-300	Capable of high yields but requires desalination treatment. Used in Aquifer Storage Recovery projects and for potable supply (desal).

Table 3: Ground Water Systems in Glades County

Aquifer System	Aquifer Unit	Thickness (Feet)	Water Resource Potential
Surficial Aquifer System	surficial Aquifer	20-100	Low yield in most areas for private domestic supply, but water quality is poor near Lake Okeechobee.
Intermediate Aquifer System	Sandstone Aquifer/ Mid- Hawthorn Aquifer	90-230	Adequate in most areas for private domestic supply and too small to moderate irrigation.
Florida Aquifer System	Lower Hawthorn Aquifer/ Suwannee Aquifer	500-1,400	Aquifer is under flowing artesian conditions throughout Glades County. The aquifer is highly productive. Productivity generally increases with depth: however, chloride, TDS, and sulfate concentrations increase with depth throughout the county. Aquifer is unsuitable for irrigation in southern Glades County.

Table 4: Ground Water Systems in Hendry County

Aquifer System	Aquifer Unit	Thickness (Feet)	Water Resource Potential
Surficial Aquifer System	Water Table Aquifer	0-100	Productivity varies widely. High iron content and color. Used for agricultural irrigation in SE County
	Lower Tamiami Aquifer	0-135	Most productive aquifer in Hendry County. Heavily used in the southeast county area. Thin or nonexistent in the northern and western portions of the county.
Intermediate Aquifer System	Sandstone Aquifer	0-120	Occurs in western Hendry County. High quality but moderate yield. Heavily used in this area resulting in significant reductions in potentiometric head.
	Mid-Hawthorn Aquifer	Insufficient Data	Limited occurrence in Hendry County. Very low productivity; moderate to high salinity, water quality most suitable for most small irrigation uses.
Florida Aquifer System	Lower Hawthorn/ Suwannee Aquifer	No Data	Little is known about the Floridan in Hendry County. It is believed to be capable of producing large volumes of saline water through flowing wells. Water is suitable for irrigation with blending.

Table 5: Ground Water Systems in Lee County.

Aquifer System	**Aquifer Unit**	**Thickness (Feet)**	**Water Resource Potential**
Surficial Aquifer System	Water Table Aquifer	20-80	Yields moderate amounts of high quality water. Susceptible to saltwater intrusion nears the coast although yield along the coast is low.
Intermediate Aquifer System	Lower Tamiami Aquifer	0-140	Absent from northern Lee County. Where present, yields moderate to large amounts of high quality water. Contains saltwater along SW Lee County coastline where no new demands are being permitted from this source.
	Sandstone Aquifer	0-110	Used extensively for agriculture and potable supply in east central Lee County. Moderate yield with high quality water, low leakancce. Large scale drawdowns exist.
Florida Aquifer System	Mid-Hawthorn Aquifer	40-120	Yields small quantities of good quality water in Cape Coral and central Lee County. Low yield storativity and leakance. Used extensive for domestic self supply and minor irrigation. Drawdowns exceed 80 feet.
	Lower Hawthorn/ Suwannee Aquifer	150-300	Capable of high yields but requires desalination treatment. Well suited for Aquifer Storage and Recovery systems and public water supply via desalinization.